ASPHERIC INTRAOCULAR LENS

FIELD OF THE INVENTION

This invention relates to intraocular lenses and more particularly to an improved intraocular lens.

BACKGROUND OF THE INVENTION

The problem of restoring useful vision to a human eye after its cataractous natural lens has been removed has been with us since the introduction of cataract surgery. The solution to this problem has included the use of spectacle lenses, contact lenses, and permanent implantation into the eye of a man-made lens, i.e., an intraocular lens.

Since 1949, when the first implant of an intraocular lens was made, hundreds of thousands of persons have had such implants. Recent advances in cataract surgery have now made the intraocular lens implant procedure a safer and more popular alternative. For example, it is estimated that nearly 40% of the people now undergoing cataract surgery select a lens implant, i.e., an intraocular lens, instead of wearing contact lenses or thick cataract-type spectacles.

In addition to advances in surgery which enhance the desirability of intraocular lens implants, there have also been advances in the design of such lenses. Two significant advances in intraocular lens design have been the use of ultrasound eye measurements to determine lens prescriptions and the use of surgical keratometers to reduce visual aberrations (astigmatism) produced by the incision on the cornea. In light of these advances, it is estimated that between about 72 and 82% of intraocular lens implant patients achieve 20/40 vision or better.

A lens implant differs from contact lenses and cataract spectacles in that it is permanently implanted within the eye. This 24-hour vision correction has been considered an advantage by proponents of lens implants. The intraocular lens must sufficiently meet the visual requirements of the patient without a natural lens. The lens implant has proven in many cases to restore a normal level of activity to the aged cataract patient. Ideally, the lens implant should provide the same or better visual acuity and comfort as that of healthy crystalline lenses before removal.

Most senior citizens express a need to avoid dependence upon relatives and friends and to avoid institutionalization in a nursing home. One of the key factors in maintaining an independent life style for senior adults in the ability to maintain a driver's license. Vision of 20/40 is obtained by a majority of lens implant patients which meets the driver's license requirements in most states.

While the vision of the post-operative cataract patient tested in the eye doctor's office is often adequate to qualify for a driver's license, serious visual deficits are reported in night vision among some patients including double images, halos around light, glare, and ghost images.

Light rays of different wavelengths within the visible color spectrum are all refracted at different angles, and thus do not converge on a unique focal point. This is known as chromatic aberration. Of greater consequence is spherical aberration. This is the inherent aberration of spheric lenses caused by the fact that the lens has a longer focal length for rays near the center than for rays passing through the outer zone. Spherical aberration is commonly attributed by surgeons as the cause of patient complaints of visual flare, glare, halo or "dazzle" and "glitter".

These aberrations are not generally present where the natural crystalline lens is healthy and performing its function. Principally the aberrations are avoided in that the lens is aspherically shaped and causes a variation in refractive index at different distances from the edge wherein the index is higher in the center and relatively lower at the edges.

Attempts have been made to correct for these aberrations in spectacles and contact lenses where the natural lens has been removed. See, for example, *Problems and Compromises In The Design of Aspheric Cataract Lenses,* American Journal of Optometry, Vol. 36, No. 6, June 1959. Further, the possibility of an aspheric intraocular lens is mentioned by M. Jalie in an article entitled *The Design of Intra-Ocular Lenses,* British Journal of Physiological Optics, Vol. 32, Pages 1–22, 1978 and in an article entitled *Designing A New Intra-Ocular Lens,* The Ophthalmic Optician, Apr. 28, 1979 but it is suggested that the uncertainty inherent in any attempt to duplicate the performance of the human eye at wide pupil diameters may obviate any advantage that an aspheric surface provides.

SUMMARY OF THE INVENTION

This invention relates to an intraocular lens for implantation into a human eye. The lens is aspheric in that it has a plurality a radii of curvature from the apex to the edge with the radii generally increasing away from the apex. This aspheric lens eliminates most of the spherical aberrations by the use of the progressively longer radii towards the outer zone of the lens.

DRAWINGS

These and other features, aspects, and advantages of the present invention will be more fully understood when considered with respect to the following detailed description, appended claims, and accompanying drawing, wherein:

FIG. **1** is a schematic horizontal section of an eyeball;

FIG. **2** is a diagram of a theoretical spheric lens producing a single focal point from a point source.

FIG. **3** is a diagram of the focusing of collimated rays by an actual spheric lens and the resultant spherical aberration.

FIG. **4** is a plan view of an exemplary embodiment of an intraocular lens provided in accordance with the practice of principles of this invention.

FIG. **5** is a side view of the intraocular lens of FIG. **4**.

FIG. **6** is a schematic of a lens showing the convention for the coordinates Z and Y.

DETAILED DESCRIPTION OF THE DRAWINGS

In FIG. **1**, there is shown a schematic of an eyeball about the horizontal middle section. The eyeball is formed by an outer shell **10** that is filled principally with a jelly-like substance (vitreous humor) which maintains the shape. The front portion of the eyeball is the cornea **11**, which is clear and provides most of the refraction power of the eye. Behind the cornea is the anterior chamber **12** that is filled with aqueous humor which is a watery fluid. The eye further includes an iris **13** which forms a pupil **14** that varies in size, typically from less than 2 mm. to about 8 mm. in diameter as the iris **13** expands and contracts to control the amount of light